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EFFECT OF PARTIALLY SHADED CONDITION ON PV MODULE

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ABSTRACT

Daily usage of such systems usually produces non-uniform string connected behavior due to partial or total shading. In these conditions, less illuminated cells transform into power receivers, thus producing supplementary losses and local panel heating.

This problem, known as mismatch (hot-spot), can reduce the power output of the array and lead to cell degradation through localized heating of individual cells. Such problems can arise simply through the shading of a single cell.

For these purposes this paper will submit to your attention simulation of shading effects in arrays with series configuration has been done; an analysis has been made of the power dissipation with the influence of the shaded degree and the I(V) characteristics with the influence of the shaded too

KEYWORDS: Shading, Reverse Bias, Hot Spot, Shading Effects, Power Dissipation

INTRODUCTION

It has been observed a significant increase renewable energy sources. There are among thesesolar and wind energy [1], [2]. There are some of using these sources. For instance: availability and low environmental impact [3]. Photovoltaic solar energy has several applications, such as electric cars, satellites, communication systems in remote locations, pumping systems and others. The installed capacity has grown exponentially as shown in

2010 it reached a value of 39.5 GW, and in 2009 alone there was an increase of 16.6 GW. According to installed power in 2015 will be something around 131.3 GW. The performance of a photovoltaic solar system is mostly dependent on climatic conditions [5]. The incident solar radiation and temperature are factors that significantly contribute to its power generated [6], [7], [8].

The total DC power in such network is, however lower than the sum of the individual rated power of each module. The main reasons are static mismatch, environmental stress and shadow problems. Dynamic mismatches occurs when the modules operates far from its maximum power point. The PV modules connected in parallel or in series cannot operate in their individual maximum power point because the voltage (in case of parallel connection) or current (in case of series connection) is forced to be equal in all the modules of the string [9]

The shaded cell operates in reverse bias region to match this condition and cause a power loss to the system. This power is dissipated as heat and hence, causes ‘hot spots’. The probability that some cells in module or some modules in the string are potentially able to deliver strongly different currents in operating conditions is very high [10],

To study mismatch losses, mathematical modeling is done for the PV system and the simulation has been performed using MATLAB. Further, the effects of partial shading without bypass diodes are investigated.

Reverse Characteristics

In the absence of bypass diodes, if the solar radiation is not uniform across all solar cells in the series connected modules, the mismatching causes the shaded solar cells to be driven into the negative voltage region.

Hence for partial shading analysis study of reverse characteristics is very much important.

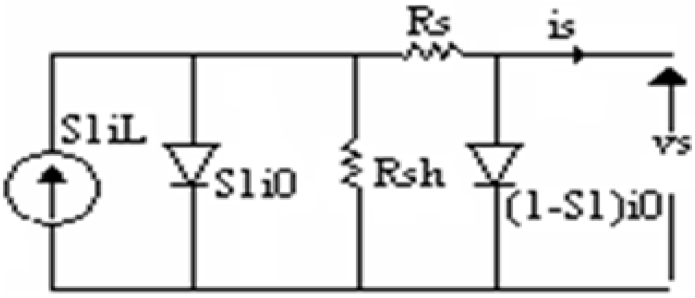

Figure 1: Equivalent Circuit of Shadowed Solar Cell

The dark I-V or reverse I-V characteristics of solar cell has been modeled using following equation.

$$i_s(v_s) = Qi_L - Qi_0\left\{\exp\left[\frac{(v_s + i_s R_{s1cell})}{V_T}\right] - 1\right\} - \frac{(v_s + i_s R_{s1cell})}{R_{sh1cel}} - (1-Q)i_0\left[\exp\left(\frac{v_s}{V_T}\right) - 1\right] \quad (1)$$

For fully illuminated cell (Q=1).

The current passing through the shadowed cells is can be obtained from equation (1) by replacing v_s by v_G . As v_G is negative and neglecting $i_s R_s$ with respect to v_G, equation (1) reduces to,

$$i_s = \frac{Qi_L R_{sh} - v_G}{R_s + R_{sh}} \quad (2)$$

the dissipation power in the shaded cell P_D is given by,

$$P_D = |i_s v_G|$$

Since the partially shadowed cell is generally reverse biased then the voltage across the group of cells that includes y partially shadowed cells v_G

$$v_G = -i_L R_{sh}\left\{\frac{y}{m}(1-Q) + \left(\frac{i}{i_L}\right)\left(1 + \frac{R_s}{R_{sh}}\right) - 1\right\} \quad (3)$$

$$P_D = |i_s v_G| = \frac{i_L^2 R_{sh} f}{1 + (R_s / R_{sh})}(f + Q) \quad (4)$$

Where

$$f = \frac{y}{m}(1-Q) + \frac{i}{i_L}\left(1 + \frac{R_s}{R_{SH}}\right) - 1 \quad (5)$$

If $y = m = 1$, becomes

$$P_D = iR_{sh}(i - Qi_L) + i^2 R_s \quad (6)$$

RESULTS

I(V) Characteristics

From the simulation conducted our numerical model of a solar cell, by the method of Dichotomy, we get the current-voltage characteristic as shown in Figure 1.

- The current generated by the solar cell is thus a function of the working voltage of the cell V.
- For voltages below a 0.35V, the current remains independent of the voltage, the devise acts as a current generator.
- From the voltage higher a 0.4Vthe current varies and the voltage remains practically constant.

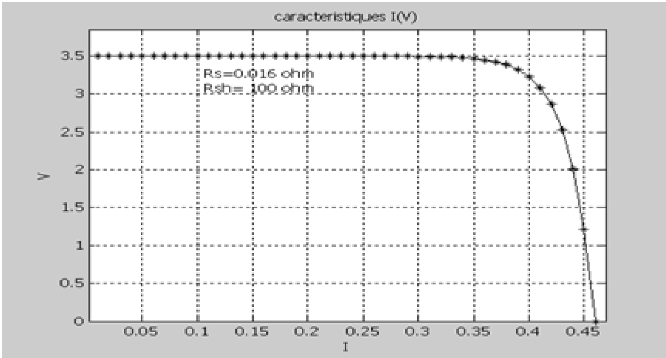

Figure 1: I (V) Characteristic of One Cell

Module

I-V curve of the PV module is affected decisively when one solar cell is shadowed at different degrees. In order to demonstrate this, the module in which all the 36 solar cells are series connected and out of which one cell is partially shaded to different is degrees simulated. Resultant characteristics of the whole module in partial shading have to be obtained. For this, as the solar cells are connected in series, for the given current the voltage has to be calculated by adding the corresponding voltage of shaded cell and non-shaded 35 cells. The shaded solar cell has significantly narrowed the current path in the module.

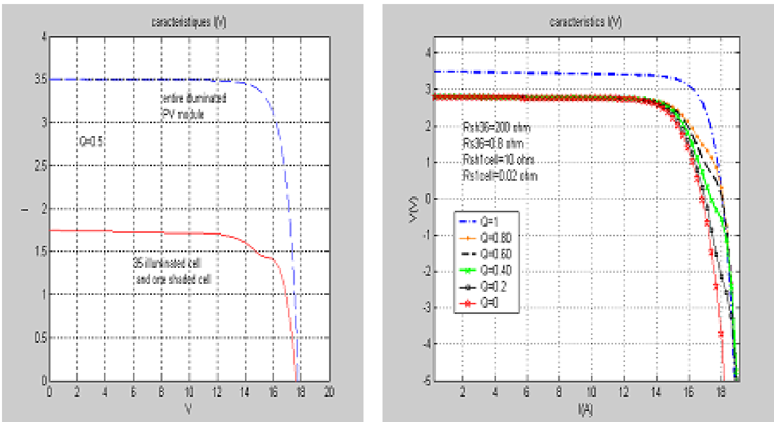

Figure 2: Effect of the Shadowed Degree in the I-V Characteristics

Power Dissipation

The influence of the shadowed degree on the power dissipation represent in the figure (III).The the shadowed degree (Q) has a very significant effect on the power dissipation, the power dissipation increases with increasing of the shadowed degree.

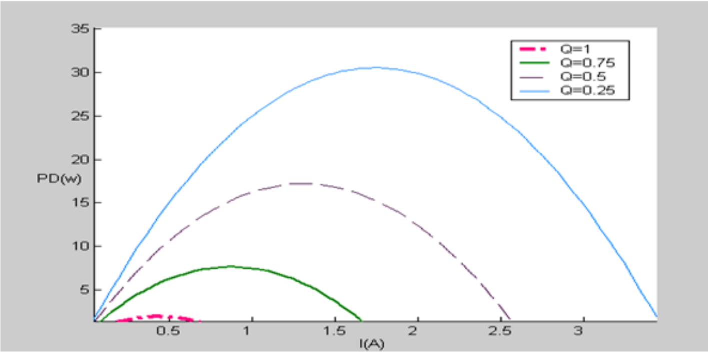

Figure 3: Effect of the Shadowed Degree in the Power Dissipation Characteristics

CONCLUSIONS

Partial shading of solar generators may cause big losses and unbalanced performance ratings. Shaded cells are frequently involved in negative ranges of voltages.

The influence of the shading on the power dissipation characteristic of the module has been evaluated in the way that a different number of the solar cells have been shaded. The results show that the influence of the shading cannot be neglected..

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